Heavy-Flavor Tracking in STAR

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Quantum Chromodynamics(QCD) is the fundamental theory of strong interactions. Calculations within the framework of regularized lattice QCD [1] predict a phase transition of ordinary nuclear matter into a de-confined and locally thermalized state of quarks and gluons, the Quark-Gluon Plasma (QGP). Here, thermalization requires copious interactions among constituents necessarily leading to the development of collectivity.

Ultra–relativistic nuclear collisions at highest energies are the only tool to create a QGP in the laboratory. The measurement of collective flow of the multi-strange baryons Ξ and Ω in Au+Au collisions at RHIC established that collectivity develops at the partonic level. This puts the question of deconfinement over volumes large compared to the size of hadrons at rest. The degree of thermalization at the partonic level is still to be answered.

Since the charm quark mass in the order of $\approx 1.1 - 1.5$ GeV/c^2 is much larger than the predicted temperature of a QGP, the information of thermal equilibrium might be extracted from the collective behavior of the charmed hadrons. The strength of the charm hadron collective elliptic flow is potentially an indicator of thermalization occurring at the partonic level. If charm hadrons flow together with the light flavor hadrons, there must be copious interactions among light flavor quarks and charm quarks. Therefore, thermalization must be reached through parton re-scatterings.

The Heavy–Flavor Tracker (HFT) is designed to measure open charm and open beauty near mid-rapidity by identifying the secondary decay vertex. For those extremely short lived particles this requires very good position measurement as close as possible to the interaction point (spatial resolution of the order of 10 μm) and a very low mass setup in order to minimize single and multiple Coulomb scattering before the first position measurement.

Tracking performance in the Heavy–Flavor Tracker detector has been studied using $\sqrt{s_{\rm NN}}$=200 GeV central collisions generated by the hijing event generator. Generated events were processed by the GEANT detector simulation program and a detailed response simulation for the Time Projection chamber (TPC) and the Silicon Vertex Tracker (SVT).

Hits in the Heavy–Flavor Tracker were smeared in the x-y direction by a Gaussian function with a realistic width of σ=6 μm. Tracks with more than 15 hits in the TPC, 2 Hits in the SVT and 2 hits in the Heavy–Flavor Tracker detector were reconstructed with the STAR inner tracker code. Figure 1 shows the efficiency for reconstructing tracks of charged hadrons from central Au+Au collisions within pseudo–rapidity $|\eta| < 0.75$ in the TPC (open circles), SVT (open triangles) and the Heavy–Flavor Tracker (closed circles). The efficiency at lower transverse momentum is restricted due to the detector acceptance and saturates at larger momentum. Tracking from the TPC to the next inner sub–detector, i.e. the SVT, requires extrapolation of tracks over a distance of 50 cm. The finite tracking resolution implies uncertainties leading to a decrease in tracking efficiency. Further studies to improve the overall matching between TPC and SVT tracks are under way. Due to the expected high luminosity at RHIC and the restricted readout speed of the HFT, up to 40 Au+Au collisions pile-up in the detector. This comprises formidable challenges to the tracking algorithms. From our simulations, we estimate the contribution of ghost tracks, i.e. reconstructed tracks with at least one associated hit from another track, to be less than 5% at transverse momentum $p_T > 1.0$ GeV/c. Optimization of our tracking algorithms to increase the efficiency in the Heavy–Flavor Tracker and to minimize the contribution of ghost tracks is work in progress.

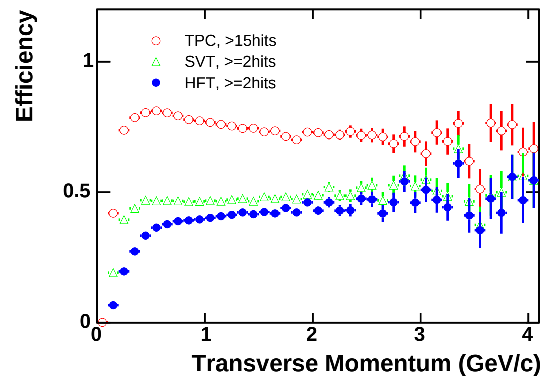

FIG. 1: Efficiency for reconstructing tracks of charged hadrons from central Au+Au collisions within pseudo–rapidity $|\eta| < 0.75$ in the TPC (open circles), SVT (open triangles) and the Heavy–Flavor Tracker (closed circles) as a function of transverse momentum.

[1] F. Karsch, Nucl. Phys. **A698**, 199c (2002).